Comparison of Hearing Screening Protocols for Preschoolers, Infants, and Toddlers

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Abstract

Purpose: The purpose of this research was to compare the outcomes of two hearing screening protocols for preschoolers, toddlers, and infants: (1) Using only transient evoked otoacoustic emissions (TEOAEs); and (2) Using TEOAEs, immittance, otoscopy, and pure-tone screening.

Method: This research consisted of a secondary data analysis of hearing screening results from 592 preschoolers, toddlers, and infants screened in Albany County, Wyoming. Data was collected by the Wyoming Early Hearing Detection and Intervention program and analyzed using the statistical software program SPSS 22.

Results: Results of a Pearson chi-square analysis showed no significant difference between the two hearing screening protocols.

Conclusion: There was no significant difference in sensitivity and specificity of the two hearing screening protocols. Using TEOAEs only is an efficient, low-cost hearing screening protocol that could maximize the early identification of infants, toddlers, and preschoolers with hearing loss and allow them the opportunity to benefit from early intervention

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Introduction

The early identification and intervention of hearing loss in infants, toddlers, and preschoolers is essential for proper auditory, speech, language, and socioemotional development (Eiserman, Shisler, Foust, Buhrmann, Winston, & White, 2007). Unmanaged hearing loss can cause deficits in development of these abilities, but improved development in children with hearing loss can be achieved with early intervention (Busacco, 2010). Information provided by hearing screening tools including transient evoked otoacoustic emissions (TEOAEs), immittance testing, otoscopy, and puretone testing identify hearing loss in children that could have a negative effect on their development (Smiley, Shapley, Eckl, & Nicholson, 2012).

Hearing screenings

Hearing screenings must be effective, especially in the infant, toddler, and preschooler populations. Loss of hearing in these populations may cause delays in speech, language, cognition, and social aspects, making early intervention important for proper development (YoshinagaItano, 2004). The earlier the hearing loss is identified and intervention is implemented, the greater chance the child will have the opportunity to develop typically alongside their sameaged peers (Busacco, 2010). Failure to identify a hearing loss in a young child, therefore, can result in major setbacks developmentally and educationally. Hearing screening protocols with the best sensitivity and specificity should maximize identification of those who have hearing loss so they may be referred to an audiologist for further diagnostic testing (Smiley, et al., 2012).

EHDI Program

Early Hearing Detection and Intervention (EHDI) programs have been established in every state and territory in the United States to ensure every child born with a hearing loss has been identified (White, 2008). Newborn hearing screenings are used to identify hearing loss in infants before they leave the hospital. However, newborns may not be screened if they were born at home or in a rural community, or due to health-related issues. An estimated 20% of childhood hearing loss is progressive, worsening over time, or is acquired (due to disease, trauma, or environmental factors) after the newborn hearing screening period (Georgalas, Xenellis, Davilis, Tzangaroulakis, & Ferekidis, 2008). The potential for missing infants and children due to progressive and acquired hearing loss increases the need for hearing screenings later in childhood.

Current ASHA Protocols

The American Speech-Language-Hearing Association (ASHA) has certain protocols that are recommended for conducting a hearing screening. ASHA firsts recommends that screenings of children should mainly depend on physiological measurements of hearing function (Madell, J., & Flexer, C., 2008). These include tests such as auditory brainstem responses and otoacoustic emissions (OAEs). Additional information gathered include a case history, caregiver support, an observation of the child's behavioral response to variations in sounds, a developmental screening, and a functional hearing screening (Madell, J., & Flexer, C., 2008). The second protocol deals with age ranges below the scope of this research project. The third and final ASHA protocol suggests that when screening children twenty-five to sixty months old, behavioral tests, such as pure-tone audiometry, and acoustic immittance testing are adequate measures of hearing loss. Speech perception tests, developmental screenings, and functional auditory assessments must also be included in the hearing screening (Madell, J., & Flexer, C.,

2008). Specific hearing screening tools used in this research include TEOAEs, immittance, otoscopy, and pure-tone screening.

Otoacoustic emissions

Otoacoustic emissions are an important tool for identifying hearing loss and can be used for additional diagnostic testing (Madell, J., & Flexer, C., 2008). OAEs serve to determine whether or not there is a hearing impairment originating in the cochlea by looking specifically at outer hair cell (OHC) functioning. The two types of OAEs include distortion product otoacoustic emissions (DPOAEs) and transient otoacoustic emission (TOAEs) (Busacco, D., 2010). This research project will use TOAEs for hearing screening purposes.

Immittance testing

Immittance testing is another screening tool being used in this research project. Immittance testing includes assessing the individual's ear canal volume, middle ear pressure, tympanic membrane compliance (tympanometry), and acoustic reflex. Tympanometry is used to determine the mobility of the tympanic membrane. Changes in air pressure created by a tympanometer are measured, making tympanometry a fast and easy way to assess the status of an individual's middle ear cavity (Maddell, & Flexer, 2008). Acoustic reflex is the contraction of the stapedius and tensor tympani muscles in the middle ear cavity that occurs in response to a loud noise that has the potential to damage the auditory system. When hearing loss is present in an individual, the acoustic threshold may be elevated or absent (Busacco, 2010).

Otoscopy

Otoscopic examination is another tool that provides information about a child's hearing. Otoscopy involves a clinician inserting an otoscope into the external ear canal to visualize the canal and the tympanic membrane (Madell, J., & Flexer, C., 2008). Light from the otoscope

increases visualization and the external ear canal is magnified to assess whether the patient has any pathology that may influence hearing (i.e. inflammation, infection, obstructions, drainage, perforation, etc.) (Busacco, D., 2010).

Pure-tone screening

Pure-tone screening is a behavioral hearing screening test that determines the softest tones individuals can hear fifty percent of the time, or their hearing threshold. The individual being tested is asked to respond when he/she hears the noise presented by raising a hand, pressing a button, or by verbally indicating a sound was heard (Busacco, 2010). Individuals screened with pure-tones in this research were screened at 1000, 2000, and 4000 hertz (Hz).

Hearing screening protocol must be assessed in order to ensure individuals with a hearing loss are properly referred for additional diagnostic testing. Effective hearing screenings are crucial in the infant, toddler, and preschool populations because hearing loss may have negative effects on speech, language, and socio-emotional development (Eiserman, et al., 2008). Children learn the sounds that compose their language by listening to and observing the people around them (Yoshinaga-Itano, 2004). Hearing loss distorts the information they take in and consequently influences their speech and language development (Smiley, et al., 2012).

Transient evoked otoacoustic emission for screening

TEOAEs are a fast, objective, and easy way to screen for a hearing loss, making it a good replacement for other hearing screening protocol. On average, pure-tone screenings can be completed in approximately seven minutes. This can be compared to the estimated two minutes taken to complete an OAE screening (Foust, Eiserman & Shisler, 2011). OAEs are an objective way to screen hearing, meaning they do not require the child to actively participate in the screening and do not need to be conditioned to a specific task. These are both required of the

individual being screened using pure-tones, and because of this, results of pure-tone screenings must take into account participant error (Nozza, 2001). In addition, the ability of OAEs to detect both middle and inner ear disorders that could contribute or cause hearing loss make it possible for clinics and schools to spend less money on hearing screening equipment. These features of OAEs make them a good alternative to hearing screening protocols requiring more time, participation of the child, and money (Nozza, 2001).

The purpose of this research study was to compare the outcomes of two hearing screening protocols for preschoolers, toddlers, and infants: (1) Using only transient evoked otoacoustic emissions (TEOAEs); and (2) Using TEOAEs, immittance, otoscopy, and pure-tone screening. The participants' results (i.e. pass or fail) of the overall screening and the TEOAE screening are compared.

Reliable and efficient hearing screening tools are essential for early identification and intervention of hearing loss (Eiserman, et al., 2008). Screening protocols cannot be effective without the use of proper screening tools. These tools determine which individuals are in need of further diagnostic testing and must follow specific protocols (White & Muñoz, 2008).

The aim of this research was to compare two methods of hearing screening using 1) TEOAE only and 2) TEOAE, otoscopy, immittance testing, and puretone screening.

Methods

This research was a secondary data analysis of hearing screenings completed within the Wyoming Early Hearing Detection and Intervention (EHDI) program.

Participants

Participants included hearing screening records from 709 infant, toddler, and preschool children living within Albany County, Wyoming. Their mean age was 41 months (ranging from

4 months to 70 months). The children received hearing screenings using TEOAEs, immittance, otoscopy, and/or puretone screening. This research was approved as exempt by the University of Wyoming Institutional Review Board (IRB).

Procedures

Results from these hearing screenings were recorded on paper forms and stored at the EHDI office. EHDI program officials de-identified hearing screening results and provided these de-identified records for this study. These paper records were computerized using a dual data entry procedure. Any discrepancies between first and second entries were resolved using the paper hearing screening forms.

Data Analysis

Descriptive statistics and frequency data were compiled for this data set. A Pearson chi-square was used to determine statistically significant differences between the two screening protocols. Data analysis was completed using SPSS 22 (2013).

Results

Results include screenings of both ears (N= 1418) for the 709 children . From that total, 853 ears were screened using the complete battery of TEOAE, otoscopy, immittance testing, and puretone screening.

Eighty eight percent (n=753) of ears screened with the complete battery passed all hearing screening measures. Only 4 ears (0.4%) passed the TEOAE screening but failed the overall screening battery. All ears that failed TEOAE screening also failed the complete screening battery. Ninetysix participant ears failed overall screening and failed the TEOAE screening (11%). Crosstabulation results in a 2x2 contingency table which will be reported in the ASHA presentation. 100% sensitivity and 100% specificity. A Pearson Chisquare test [χ 2 (1,

N=853) =814.6; p= .0005)] revealed there was not a statistically significant difference between the overall screening protocol and the TEAOE screening.

Discussion

Results from this research revealed similar pass and fail rates when comparing the two hearing screening protocols. This suggests that screening with only TEOAEs would be a time-effective screening measure as compared to the longer, complete screening battery.

Factors such as background noise or outer/middle ear issues may have caused the disagreement between the two protocols in the four cases. For example, background noise is a factor that, if loud enough, could cause the participant to fail a puretone screening. This noise could also influence the measurements in the TEOAE screening. Cerumen and middle ear pathology could also affect the results of the hearing screenings.

Limitations of this research include the secondary data analysis of written records. Any errors within the written records cannot be corrected. Realtime computerization of hearing screening results could limit entry to a range of possible answers and reduce some errors and standardize entries. These results were from one geographical region of the state. Computerization of hearing screening across the state would allow analyses for regional effects including training of different screeners.

Further research could examine reasons for why some children were unable to be screened. Additional questions include analysis of the ages of children receiving TEOAEs versus the age of those receiving puretone screening, and examining the rescreens and audiological or medical followups of the participants that failed the hearing screening.

Hearing screenings for preschoolers, toddlers, and infants is crucial for proper auditory, speech, language, and socioemotional development (Eiserman et al., 2007). Hearing loss can

lead to developmental delays in these areas, however, early detection and identification can lead to improved development. Continued advances in technology lead to more effective and accurate hearing screening protocols.

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